CHAPTER IV

LIPID PROFILE AND LIPID PEROXIDATION IN CKD

4.1 INTRODUCTION

Chronic Kidney Disease (CKD) is characterized by specific metabolic abnormalities of plasma lipids both qualitatively and quantitatively (Attman et al., 1993). Most common lipid abnormalities encountered are increased serum triglycerides and decreased serum HDL cholesterol with small alteration of other lipoprotein fraction in serum and in dialysis patients there is more of a dyslipidemia rather than hyperlipidemia (Deighan et al., 2000). Hyperlipidemia is the major cause for vascular complications that leads to increase mortality in CKD individuals.

Reactive Oxygen Species for preserving cellular physiology ROS should be produced at constant level by non phagocytic cells. Disturbances in production of ROS results in oxidative stress and loss of homeostasis in redox potential finally resulting in progression of pro inflammatory pathways in kidney (Sandau and Brune 2000). Formation of ROS is predominant in renal cortex and medulla is suspected to hypoxic condition when there is a less production of ROS (Zou and Cowley, 2003) (Bedard and Krause, 2007).

In CKD patients the extent of oxidative stress within and outside the cell is related to severity in renal failure (Massy and Nguyen, 2002). The oxidative stress depends on the excess production of free radical coupled with low concentration of antioxidants. It is observed that free radical induced lipid peroxidative tissue damage has played a major role in the pathogenesis of various renal diseases. Lipid peroxidation is assayed indirectly by production of secondary products like water soluble three carbon, low molecular weight reactive aldehyde known as malondialdehyde (MDA). Assessment of antioxidant status can also be measured by estimating SuperOxide Dismutase (SOD).
An attempt has been made in this study to assess the lipid profile and oxidative stress as evidenced by serum MDA and plasma SOD activity an attempt has been made in this study.

4.2 MATERIALS AND METHODS

4.2.1 Selection of cases
The study comprises of a total of 113 patients with evidence of CKD who were admitted into Nephrology unit of MIMS hospital, Nellimarla. The CKD cases were further divided into 2 groups i.e., a nondialysis group (stages I-IV) numbered 50 patients and end stage renal disease (ESRD) group (stage V) who were under hemodialysis comprising of 63 patients. They were included in the study on the basis of clinical signs and symptoms of kidney disease along with an elevated blood urea and serum creatinine level and a lowered eGFR. Patients with eGFR values of less than 15 ml/ min were included under stage V (ESRD) and rest of the others whose eGFR ranged from 90 ml/min to 15 ml/min were grouped under stages I to IV. The ESRD patients were under hemodialysis in nephrology unit, for 3 to 4 hours per day and 2-3 times in a week for the last 6 months to 3 years. The nondialysis patients were under conservative medical therapy.

Inclusion criteria: Diagnosed cases of CKD both nondialysis and hemodialysis were included.

Exclusion criteria: Patients with Viral hepatitis, HIV positive, Cancer, Myocardial infarction, smokers and alcoholics were excluded.

4.2.2 Selection of control
The control group comprised of 50, age and sex matched healthy subjects who are free of features associated with kidney disease and having a normal blood urea and serum creatinine level. Individuals suffering from diseases which likely modify their lipid profile as well as their oxidative and antioxidative status, were excluded from the study. Likewise persons with history of drugs which are likely to modify the lipid profile, oxidative and antioxidative status were also excluded.
Ethical committee approval was obtained from Maharajah’s Institute of Medical Sciences. Informed consent was taken from the patients and controls who participated in the present study. Patient were informed the importance of the study, procedures to be performed and benefits of the study.

4.2.3 Estimation of Serum Triglycerides
Serum triglycerides were estimated by glycerol phosphate oxidase (GPO) method using ERBA kit (Mc Gowan et al., 1983). In this procedure 1.0ml of triglycerides working reagent and 10µl of serum was added and was considered as test (T). In the Standard(S) 1.0ml of triglycerides working reagent and 10µl of triglyceride standard was added whereas in blank (B) 1.0ml of triglycerides working reagent and 10µl of distilled water was added. All the tubes were mixed, incubated for 10min at 37°C and the absorbance of each test tube was read at 505nm.

4.2.4 Estimation of Serum Total cholesterol
Serum cholesterol was estimated by Cholesterol Oxidase (CHOD) method using ERBA kit (Allain et al., 1974). In this procedure 1.0ml cholesterol working reagent and 20µl of serum were added and it was considered as test (T). In the Standard(S) 1.0ml of cholesterol working reagent and 20µl of cholesterol standard was added whereas in blank (B) 1.0ml of cholesterol working reagent and 20µl of distilled water was added. All the tubes were mixed, incubated for 10min at 37°C and the absorbance was read at 505 nm.

4.2.5 Estimation of Serum HDL cholesterol
Serum HDL Cholesterol was estimated by phosphotungstic acid method using ERBA kit (Burstein et al., 1970). The serum chylomicrons, LDL and VLDL are precipitated using phosphotungstate in the presence of divalent cation such as magnesium. The HDL cholesterol remains unaffected in the supernatant. Based on the above principle 0.25ml of serum was taken in a test tube and 0.5ml of precipitating reagent was added. It was centrifuged and the supernatant was collected. To 50µl of supernatant 1.0ml of cholesterol working reagent was added and it was consider as test (T). In the Standard(S) 1.0ml of cholesterol working reagent and 50µl of HDL cholesterol standard was added whereas in blank (B) 1.0ml of cholesterol working reagent and
50µl of distilled water was added. All the tubes were mixed, incubated for 10min at 37°C and the absorbance of each test tube was read at 505 nm.

4.2.6 Estimation of Serum LDL Cholesterol and Serum VLDL Cholesterol
These two are measured by indirect method in accordance with the online Friedewald formula, provided serum triglyceride level is not above 400mg/dl; otherwise direct estimation of LDL-C is done by ultracentrifugation (Friedewald et al., 1972).

The Friedewald Formula is

\[
\text{LDL-C (mg/dl)} = \text{Total cholesterol-(HDL-C+VLDL)}
\]

\[
\text{VLDL-C (mg/dl)} = \frac{\text{Triglyceride}}{5 \text{ mg/dl}}
\]

4.2.7 Estimation of serum Malondialdehyde (MDA)
The serum malondialdehyde was estimated by Satoh (1978) method. To 0.5ml of serum, 2.5ml of 20mg/dl trichloroacetic acid is added and allowed to stand for 10min at room temperature. Later it was centrifuged at 3500rpm for 10min and supernatant was decanted. To the precipitate 0.05M Sulphuric acid was added and washed once. To this precipitate 2.5ml of 0.05M sulphuric acid 3.0ml of 0.2mg/dl Thiobarbituric acid (TBA) in 2M sodium sulphate was added. The lipid peroxide coupling with TBA is done by keeping in a hot water bath for 30min. Later it is cooled and chromogen is taken out with 4M n-butyl alcohol by rigorous shaking. The organic phase is separated out by centrifuging at 3000rpm for 10min. The absorbance of the chromogen is determined at 530nm. The lipid peroxide value was estimated as MDA equivalents, on the basis of calibration curve for standard MDA.

4.2.8 Estimation of plasma SOD
Plasma SOD estimation was done by Kakkar et al., (1984) method. In a test tube 1.35 ml of double distilled water, 50µl plasma, 1.2 ml of Na-pyrophosphate buffer(1.154 gm/100ml with pH 8.3), 0.1 ml of N-methyl phenazonium methosulphate (6mg/10ml), and 0.3 ml Nitroblue tetrazolium (26 mg/dl) were taken and mixed. To initiate the reaction, 0.2 ml of NADH was added and the mixture was incubated at 39°C for 90 seconds and the reaction was arrested by addition of 1ml of glacial acetic
acid. Finally 4ml of n-butanol was added and mixed by vortexing the mixture, followed by centrifugation at 4000rpm for 10min. Formazen was extracted on upper n-butanol layer and the absorbance was taken at 560 nm against blank. The activity of SOD was calculated as percent inhibition of absorbance compared to the control.

4.2.9 Statistical analysis
Data was expressed as Mean and Standard deviation (mean ±SD). Statistical significance between control and patient groups, the Z test was performed using Microsoft Excel and SPSS software 16.0. The statistical significance was determined at 5% (p < 0.05) level.

4.3 RESULTS AND DISCUSSION

4.3.1 Demographic features and diagnostic parameters
A total of 163 subjects were studied including 50 normal healthy individuals (Control) and 113 diagnosed CKD patients. The CKD cases were further divided into 2 groups that are nondialysis and hemodialysis. Mean age of the control was 40.94±10.02, in case of CKD nondialysis it was 45.90±10.50 and CKD hemodialysis it was 45.24±11.03. As regards the sex distribution, the majority of subjects were male in control 60%, CKD nondialysis 58% and CKD hemodialysis 54%. The most common etiology in CKD nondialysis patients was diabetes (44%) followed by hypertension (32%), glomerulonephritis (14%) and polycystic kidney disease (10%). In hemodialysis patients also the common cause was diabetes (46%) followed by hypertension (35%), glomerulonephritis (9.5%) and polycystic kidney disease (9.5%).

The diagnostic criteria for CKD consisting of blood urea and serum creatinine were significantly higher (p<0.001) in CKD patients when compared to control. (p<0.001, Table 4.1). The reason attributed to raised blood urea and serum creatinine in patients with CKD is the decline in glomerular filtration.
Table 4.1: Demographic features and diagnostic parameters in controls and CKD patients

<table>
<thead>
<tr>
<th></th>
<th>Control (n=50)</th>
<th>CKD Nondialysis patients (n=50)</th>
<th>CKD Hemodialysis patients (n=63)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (mean±SD) years</td>
<td>40.94±10.02</td>
<td>45.9±10.50</td>
<td>45.24±11.03</td>
</tr>
<tr>
<td>Sex (males %)</td>
<td>60</td>
<td>58</td>
<td>54</td>
</tr>
<tr>
<td>(females%)</td>
<td>40</td>
<td>42</td>
<td>46</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td></td>
<td>44% (n=22)</td>
<td>46% (n=29)</td>
</tr>
<tr>
<td>Hypertension</td>
<td></td>
<td>32% (n=16)</td>
<td>35% (n=22)</td>
</tr>
<tr>
<td>Glomerulonephritis</td>
<td></td>
<td>14% (n=7)</td>
<td>9.5% (n=6)</td>
</tr>
<tr>
<td>Polycystic kidney disease</td>
<td></td>
<td>10% (n=5)</td>
<td>9.5% (n=6)</td>
</tr>
<tr>
<td>Blood Urea (mg/dl)</td>
<td>27.12±7.31</td>
<td>90.46±28.14**</td>
<td>125.44±28.13**</td>
</tr>
<tr>
<td>Serum Creatinine (mg/dl)</td>
<td>0.86±0.11</td>
<td>3.11±0.91**</td>
<td>7.21±1.72**</td>
</tr>
</tbody>
</table>

Legend: The above table shows mean age and sex distribution in control and cases. It also shows common etiology and diagnostic parameters.

4.3.2 Effect of triglycerides in both groups of CKD

In the present study the mean serum triglycerides were significantly elevated in both nondialysis and hemodialysis groups of CKD patients when compared with control (p<0.001). The mean serum triglycerides significantly increased in nondialysis patients when compared to hemodialysis patients (p<0.05) (Table 4.2; Figure 4.1). CKD produces characteristic effects on major lipoprotein fractions (Saland and Ginsberg 2007). Hypertriglyceridemia is one of the most common lipid abnormalities in patients with CKD (Kwan et al., 2007). The accumulation of triglycerides leading to triglyceridemia in CKD is the consequence of high production and low catabolism.
of triglycerides. But the predominant mechanism which is attributed for triglyceridemia in CKD is decreased catabolism of triglycerides (Prinsen et al., 2003). Various factors that contribute to this metabolic aberration in CKD include

a. Diminished lipoprotein lipase (LPL) activity as a consequence of the down regulation of the gene (Vaziri and Liang 1996).
b. A disproportionate increase in plasma apolipoprotein C-III which is a possible cause of lipoprotein lipase inactivation in uremia (Moberly et al., 1999).
c. In hemodialysis patients in addition to the above factors, the repeated use of low molecular heparins may also contribute to lipoprotein lipase depletion (Huttunen et al., 1978).
d. The presence of inhibitors of lipase in CKD patients (Cheung et al., 1996).

All the above factors which lead to a qualitative or quantitative decrease in LPL activity in plasma result in a decreased catabolism of triglycerides in chylomicrons and VLDL.

CKD is also associated with secondary hyperparathyroidism which leads to the impaired catabolism of triglyceride-rich lipoproteins, an additional mechanism for raised plasma triglyceride concentrations in CKD (Vaziri et al., 1997). The other alternative explanation for hypertriglyceridemia in CKD is the increased production of triglycerides. The mechanism involves impairment in tolerance of carbohydrates and enhancement of VLDL synthesis in hepatic tissue (Appel 1991). However its contribution to triglyceridemia is minimal in CKD.
Table 4.2: Comparative study of lipid profile in control and CKD Patients

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Control (n=50)</th>
<th>CKD Nondialysis group (n=50)</th>
<th>CKD Hemodialysis group (n=63)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serum Triglycerides (mg/dl)</td>
<td>113.82±17.83</td>
<td>209.80±32.43**</td>
<td>195.42±19.13**</td>
</tr>
<tr>
<td>Serum total cholesterol (mg/dl)</td>
<td>177.26±14.17</td>
<td>182.46±22.12</td>
<td>173.71±22.80</td>
</tr>
<tr>
<td>Serum HDL-C (mg/dl)</td>
<td>45.54±4.26</td>
<td>35.28±5.67**</td>
<td>29.97±3.93**</td>
</tr>
<tr>
<td>Serum LDL-C (mg/dl)</td>
<td>108.95±13.65</td>
<td>105.22±26.15</td>
<td>104.64±22.96</td>
</tr>
<tr>
<td>Serum VLDL (mg/dl)</td>
<td>22.76±3.56</td>
<td>41.96±6.48**</td>
<td>39.08±3.82**</td>
</tr>
</tbody>
</table>

** p<0.001

Legend: The mean serum triglycerides and VLDL are increased in CKD in both nondialysis and hemodialysis patients when compared to control. The increase was statistically significant (p<0.001). The mean serum HDL cholesterol was significantly decreased in nondialysis and hemodialysis patients in CKD when compared to control (p<0.001). The mean serum total cholesterol and LDL cholesterol was not significantly altered when compared with control.

4.3.3 Unchanged Cholesterol concentration in both groups of CKD

In the present study, serum total cholesterol is not altered in CKD patients in both nondialysis and hemodialysis groups when compared with control group (p=Not significant). Whereas the mean serum total cholesterol compared between nondialysis and hemodialysis it was significantly increased in nondialysis patients when compared with hemodialysis patients (p<0.05) (Table 4.2; Figure 4.1). However these levels were within normal range. Tsumura et al., 2001 observed hypercholesterolemia in their study of patients with CKD. Hypercholesterolemia in those cases was
attributed to heavy proteinuria. The mechanism attributed to hypercholesterolemia due to heavy proteinuria in CKD involves altered gene expression of HMG-COA reductase, 7 α hydroxylase and hepatic LDL receptor (Liang and Vaziri 1997). In the present study, proteinuria was minimal and hence no change in serum cholesterol level was observed. Tsimihodimos et al., (2011) reported that there is no significant change in serum cholesterol level in CKD patients, as these patients were not having any significant degree of proteinuria. Our observation in the present study was in agreement with findings of Tsimihodimos et al., 2011.

4.3.4 Unaltered LDL- C in both groups of CKD
In nephrotic syndrome, elevation in plasma LDL cholesterol is quite common observed, but not in CKD patients undergoing hemodialysis. In our study the serum LDL-C is not altered in CKD patients both in nondialysis and hemodialysis groups when compared with control group (p=Not significant). The same result was observed when nondialysis and hemodialysis groups were compared (p=Not significant) (Table 4.2; Figure 4.1). In uremic patients there is a decrease in the degradation of IDL and LDL that results in the increase of plasma residence time (Ikewaki et al., 2005). All the above modifications results in less binding of lipoproteins to LDL receptors and their related proteins. This reduced catabolism, which should have resulted in increased serum LDL is however, counterbalanced by the decrease in production of LDL, thereby resulting in normal levels of LDL in plasma. This decreased production of LDL is attributed to the decreased LPL activity (Moberly et al., 1999) which is a major manifestation in CKD. As explained earlier, our observation showed that serum LDL cholesterol level does not undergo any change in CKD patients is in agreement with Jain et al., 1991.
4.3.5 Decrease in HDL-C concentrations in both groups of CKD

In the present study, serum HDL-C is significantly decreased in CKD patients both in nondialysis and hemodialysis groups when compared with control. (p<0.001). The mean serum HDL cholesterol compared between nondialysis and hemodialysis, it was observed that there was significant decrease in hemodialysis patients when compared to nondialysis patients (p<0.001) (Table 4.2; Figure 4.2). The significant decrease of HDL-C in CKD can be attributed to

(i) Decreased levels of apolipoproteins AI and AII; the main protein constituents of HDL (Vaziri et al., 1999).

(ii) Diminished activity of Lecitin cholesterol acyl transferarase in HDL particles (Guarnieri et al., 1978).

(iii) Increased activity of Cholesteryl Ester Transfer Protein (CETP) helps in the transfer of cholesterol esters from HDL to triglyceride-rich lipoproteins (Kimura et al., 2003). All these factors lead to the reduction in serum concentration of HDL-C.
4.3.6 Rise in VLDL-C in both groups of CKD

Serum VLDL-C in the present study is significantly raised in CKD patients both in nondialysis and hemodialysis group when compared with control group (p<0.001). Whereas the mean serum VLDL was significantly increased in nondialysis patients when compared with hemodialysis patients (p<0.05) (Table 4.2). The factors which explain the increase in serum VLDL include, (i) the increased activity of CETP which increases transfer of cholesterol ester to VLDL and promotes more VLDL formation (Kimura et al., 2003). (ii) Increased apo C-III, which is an LPL inhibitor inhibiting the degradation of VLDL (Moberly et al., 1999). These factors increase the level of serum VLDL-C in CKD patients. When comparison is made between the nondialysis and hemodialysis CKD patient groups in respect of lipid parameters (Table 4.2; Figure 4.2), it is obvious that the serum triglycerides, total cholesterol, HDL-C and VLDL-C, levels are significantly decreased in hemodialysis group in comparison to nondialysis group. But there was no appreciable change in serum LDL-C level between both the groups. These changes in hemodialysis patients can be attributed to the removal of lipoproteins by repeated dialysis (Shah et al., 1994).

Figure 4.2: Mean HDL-C and VLDL-C in Control and both groups of CKD

Legend: The mean serum HDL cholesterol is decreased in nondialysis and hemodialysis patients in CKD when compared to control. The mean VLDL is increased in CKD in both nondialysis and hemodialysis patients when compared to control.
4.3.7 Increased levels of MDA in CKD patients

In the present study serum MDA value was significantly raised in CKD patients both in nondialysis and hemodialysis groups when compared with control (p<0.001; Figure 4.3). Likewise serum MDA level when compared between both the groups of CKD i.e. nondialysis and hemodialysis groups, it was observed that there was a significant elevation in hemodialysis group (p<0.001; Figure 4.3). During normal conditions homeostasis is maintained between free radical production and destruction of cellular antioxidative system. But increased free radical generation, decreased free radical inactivation due to decreased antioxidant capacity or combination of both can lead to oxidative stress. The increase in serum MDA level in both groups of CKD patients was a reflection of increased oxidative stress. Chronic kidney disease (CKD) is commonly reported to be associated with oxidative stress. Numerous sources of reactive oxygen species (ROS) were identified in CKD patients: (i) Accumulation of uremic toxins, immunologic and metabolic disorders and dyslipidemia (Locatelli et al., 2003)(ii) Phagocyte myeloperoxidase-mediated events have also been implicated with the production of oxidized low-density lipoprotein (Nguyen-Khoa et al., 1999). (iii) Advanced glycation end products and advanced protein oxidation products. Which are potent mediators of inflammation, also lead to activation of macrophages (Witko-Sarsat et al., 1998). (iv) Treatment of anemia with high levels of iron may also induce oxidative stress (Drueke et al., 2002). The massive generation of ROS is all the more damaging because CKD patients have a weaker antioxidant system due to a diet low in antioxidant vitamins (Bonnefont et al., 2000).
Legend: It was observed that the concentrations of serum MDA was significantly higher in CKD in both nondialysis and hemodialysis group when compared to controls. It was also observed that the concentration of serum MDA in CKD patients was significantly higher (p<0.001) in hemodialysis group when compared to nondialysis patients.

In hemodialysis patients the increase is further aggravated after dialysis and was found to be a statistically significant increase in serum MDA values before hemodialysis (p<0.001; Figure 4.4). Patients undergoing hemodialysis are under conditions exposed to oxidative stress. This may be commonly explained due to bioincompatibility of dialysis membrane and diffusion of hydrophilic compounds to the dialysate and influx of endotoxin from the dialysate. These factors lead to activation of macrophages and production of ROS (Locatelli et al., 2003). In addition there is a loss of antioxidants during hemodialysis sessions (Nguyen et al., 1999). All the above factors lead to raised production of free radicals which cause peroxidation.
of lipids and culminates in further rise in serum MDA level after episodes of dialysis. This is in agreement with the study of Wesen, 2011.

**Figure 4.4: Serum MDA in before and after hemodialysis of CKD**

![Bar chart showing Mean Serum MDA in nmol/mL before and after hemodialysis.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Before hemodialysis (n=63)</th>
<th>After Hemodialysis (n=63)</th>
</tr>
</thead>
<tbody>
<tr>
<td>MDA(nmol/ml)</td>
<td>6.16±0.85</td>
<td>6.83± 0.69**</td>
</tr>
</tbody>
</table>

**Legend:** After dialysis, concentration of serum MDA in hemodialysis patients increased further when compared to before dialysis and the increase is statistically significant (p<0.001).

**4.3.8 Decreased SOD in CKD both groups**

In the present study, the plasma Superoxide Dismutase (SOD) activity significantly decreased in CKD patients both in nondialysis and hemodialysis groups when compared with control (p<0.001). Likewise plasma SOD level within the groups of CKD *i.e.* nondialysis and hemodialysis there was significant decrease in the plasma SOD levels in hemodialysis group (p<0.001) (Figure 4.5)
Figure 4.5: Plasma SOD in Control and both groups of CKD

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Control (n=50)</th>
<th>CKD nondialysis group (n=50)</th>
<th>CKD Hemodialysis group (n=63)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SODU/ml</td>
<td>9.05±1.47</td>
<td>5.71±0.84**</td>
<td>3.61±0.88**</td>
</tr>
</tbody>
</table>

**p<0.001

Legend: It was observed that the plasma SOD values in CKD registered a significant decline (p<0.001) in both nondialysis and hemodialysis groups when compared to controls. It was also observed that serum SOD values in hemodialysis patients registered a significant decline (p<0.001) when compared to nondialysis patients.

When a study was conducted to assess the plasma SOD level in hemodialysis group of CKD patients before and after hemodialysis it was observed that in hemodialysis group, the decrease in plasma SOD is further declined after an episode of dialysis and this decrease was found to be statistically significant when compared before hemodialysis (p<0.05; Figure 4.6). This study is in agreement with Noleto et al., 2011. The SOD is a metalloenzyme, which is the front line defence against superoxide anions and converts them into hydrogen peroxide. The SOD activity is decreased in CKD patients owing to increased ROS load such as hydrogen peroxide, thereby exhibiting decreased SOD activity (Toborek et al., 1992). In hemodialysis three other factors contribute to a further decrease in serum SOD level: (a) Loss of Zn$^{2+}$ and Cu$^{2+}$ in the dialysate fluid which act as cofactors of SOD activity (Kiziltas et al., 2008). (b) Increased lipid peroxidation especially in hemodialysis patients results in excess consumption of antioxidant enzyme like SOD (Toborek et al., 1992). (c) A
significant reduction of SOD is also due to decreased life span of RBC (Shainkin et al., 1990). Therefore in CKD patients both in nondialysis and hemodialysis groups, there is dyslipidemia and oxidative stress.

Figure 4.6: Plasma SOD before and after hemodialysis of CKD

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Before hemodialysis (n=63)</th>
<th>After hemodialysis (n=63)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOD(U/ml)</td>
<td>3.61±0.88</td>
<td>3.11±0.76*</td>
</tr>
</tbody>
</table>

* p<0.05

Legend: The plasma SOD is decreased after dialysis when compared with before dialysis. This decrease is statistically significant (p<0.05)
4.4 CONCLUSION

In our study dyslipidemia was observed in CKD patients characterized by a statistically significant increase of serum triglycerides and VLDL with a decrease in serum HDL-C in both nondialysis and hemodialysis groups when compared with the controls. However there was no hypercholesterolemia and serum LDL-C was not significantly altered in CKD patients both in nondialysis and hemodialysis groups when compared with controls. The accompanying serum lipid alteration i.e. hypertriglyceridemia, increased serum VLDL and decreased serum HDL in CKD enhance the risk of atherosclerosis and favours higher incidence of cardiovascular complications. Therefore lipid regulation must be instituted to reduce the risk of further complications in CKD patients.

With respect to oxidative stress and antioxidant status in CKD patients, it was observed that the serum MDA level was significantly raised and plasma SOD level registered a significant decline in both nondialysis and hemodialysis groups compared with control. These factors also contribute to high morbidity and mortality in CKD patients by promoting atherosclerosis and cardiovascular complications. When serum MDA and plasma SOD levels were compared in patients with hemodialysis before and after episodes of dialysis and noted a significant increase in serum MDA and decreased plasma SOD after dialysis. Thus after hemodialysis, patients with CKD become more vulnerable to cardiac and cerebrovascular accidents due to enhanced oxidative stress and compromised antioxidant status. Therefore new approaches are to be adapted with reference to dialysis membrane and hemodialysis technique. This modification is to be potentiated with supplementing exogenous antioxidants to counterbalance the ROS which are produced in massive quantity in CKD in the hemodialysis group especially after dialysis. These corrected measures will play a crucial role in improving quality of life in CKD patients especially those who are under hemodialysis.